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SIXTY-FIFTH REGULAR MEETING, February 20th, 1883.

Colonel GARRICK MALLERY, President, in the Chair.

The election of Gen. William Birney, Dr. George M. Acker, Mr. John H. Renshawe, and Dr. John Hamilton Porter, as active members, was reported.

Col. F. A. SEELY read the following paper entitled, "AN INQUIRY INTO THE ORIGIN OF INVENTION:"

The industries of the present day, with their machinery, appliances, and products, have not escaped that inquiry into their origin which man gives to everything that is prominent in his physical or intellectual horizon. In investigating the origin of many mechanic arts and expedients research has been well nigh exhausted. The plough, the forge, the loom have been traced back to rude originals, sometimes antedating the historic period, and the account of their growth forms no small part of the history of civilization.

But with all the attention that has been paid to particular arts, processes, and mechanical appliances, it is noticeable that invention itself, the faculty through which man has wrought out his multitudinous contrivances, has scarcely attracted attention to its history. And yet, neither as a curious problem in itself, nor in its bearings on the history of the human race, does it seem unprofitable to inquire: What were the first steps by which man became an inventor? Out of what germs did he derive his first mechanical ideas? Were they original with him or borrowed? If derived from some other source, what was it? And what were the first improvements which may justly be regarded as inventions?

These questions are very different from inquiries into the origin of the steam engine, the growth of a couple of centuries; or of metal working, which does not reach far beyond the historic period; or of the loom, which cannot be as old as the use of skins for clothing. They reach back to an antiquity to which the earliest historic date is as yesterday. History barely skims the surface of these remote depths. As far back as she takes us, we find men living in the midst of mechanical appliances not widely different from to-day's. Wood and metal and stone were wrought, sometimes with effects which are the despair of our artisans, agriculture in its highest perfection was carried on, textile industries were highly developed, and the so-called mechanical powers, which constitute the elements of all our labor-saving machinery, were practically as well known as they are now.

It is equally idle to question archæology. She can guide us no further than, groping in caverns or delving in alluvium, she finds evidence of man's existence in bits of imperishable flint or charcoal; but she cannot tell us at what period of his progress he began to work the refractory flint, or found use for fire in the preparation of his food.

If we question mythology, we find no more satisfactory answer in her dim traditions and dreamy personifications of natural phenomena. She may ascribe to Osiris and Apollo the invention of the plough and the lyre, but cannot tell us when or where these personages lived, nor anything of man's vast and varied history before he attained the social condition which favored the cultivation of music, or had so far succeeded in domesticating beasts of burden that the use of the plough was possible. The mythologies reach no further than a stage of organized society. The arts at whose origin they hint are the arts of a people on a high plane of civilization.

To consider the nature of the first steps in mechanical invention, far back of history, of tradition, and of the revelations of archæological research, is the object of this paper.

In this inquiry there would at first seem to be a field for boundless conjecture, and for little certainty; but I am convinced that the subject need not be wholly left to conjecture. In all arts, the history of their progress is a history of elaboration, of successive steps, or accretions. It is by the superimposition of one slight improvement upon another, that, within the period of recorded history, they have been perfected, and we may read their history as we may count the courses in a monument, from the foundation upward, or from the capstone downward; and the process by which the monument has reached its height is as clearly legible read from the top as from the bottom. It is in this way that men whose business is with the study of inventions read their history. They pass backward from the perfected machine or product, eliminating in reverse order the successive improvements that have been made, and so arriving at successively simpler and ruder forms until the original germ is reached. It is otherwise in books. In them we trace forwards the gradual growth, for instance, of the steam engine, from the toy of Hero of Alexandria, through the crude experiments of the 17th century, the pumping machines of Papin and Savary and their contemporaries, Humphrey Potter's shrewd contrivance to relieve himself of shifting the valves, Watt's complete engine, and so on, step by step, one slight improvement upon another, until we reach the mighty engines of our own time. We cannot conveniently nor logically write history except in this direct order; but in our own minds, in scanning the history of an art, we always trace it backwards, just as the traveler looks back over the route he has passed. We separate from the perfected engine its latest improvements, always going back to less perfect forms, until we reach the clumsy pumping machine with an impatient boy pulling the valve-strings with one hand and rattling the marbles in his pocket with the other, cogitating how he can make the machine actuate its own valves while he disports himself more to his satisfaction. The valve movement removed, we next eliminate the cold water jet in the cylinder for condensation, then condensation by cold water outside the cylinder, and we have reached the stage where the steam engine is represented by a philosophical apparatus in which the energy of steam is exerted upon a piston, but with no adaptation to any practical purpose. Here is the beginning of the steam engine proper, since back of this we find nothing but speculative experiments to demonstrate the existence of energy, but with no practical notion of its utilization.

But if this is the beginning of the steam engine proper, there is in it, and fundamental to it, a mechanical appliance, without which it could never have been devised, and the origin of which we are apparently as far from as when we began. I mean the cylinder and piston common to the engine and the ordinary pump. Where this contrivance originated would be an interesting subject for special research, the lift pump in which it is so familiar to us being unknown to the ancients.* In the cylindrical bellows of China and Madagascar, however, we find an apparatus embodying these elements, probably well known in Europe during the Middle Ages. This was, no doubt, a modification of some earlier form of the bellows, more like that familiar to us. But whence came the bellows? We may reasonably presume that this rather complicated structure was elaborated from a ruder form, originating in the use of inflated skins or bladders with nozzles of reed, used in the primitive metallurgic processes of our remote ancestors. Can we go a step further? We have left only the human lips and lungs with the possible assistance of a tube of reed. Here the backward journey ends, for we have reached the limit, the possession of man in a state of nature, before any step in invention had been taken.

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* It seems probable that the idea of the force pump was familiar to the ancients. Machines constructed by Hero of Alexandria (100 B. C.) and Ctesibius (130 B. C.) are thought to have been double cylinder force pumps, lacking only the air chamber of being practical fire-engines, equal to any in use a century ago. (See *Das Feuer*, by Dr. Gustav Lindner, Brünn, 1881.) It is hard to refrain from fancying how the world's history might have been affected if Hero, in his experiments with steam, had thought of applying it to his piston and cylinder.

This process of reading the history of a machine or art, which may be called elimination, is strictly evolution read backwards. Although in passing out of the field of recorded history we work in the dark, yet, by means of this process, we work with all the certainty with which we read the geological history of the earth by boring downward through the successive strata. It is true we may err, as the geologist finds faults which, for the time, mislead or deceive him; but no doubts trouble him as to the essential truth of his science or the certainty of the results he compiles from many observations. And so, if we take up any art or machine and trace its history in this way, we may not always follow exactly the actual routes they have taken to reach their present perfection; but we shall surely, by eliminating at each step that which is clearly an improvement or modification of some earlier form, arrive ultimately at as rude mechanical expedients as the remote germ out of which the idea of the steam engine appears to have sprung. And we may be certain that in the contemplation of any structure, however rude, we have not reached its ultimate origin so long as it shows a trace of improvement upon a ruder form or an earlier art.

Let us apply the process of elimination to an instrument quite simple, but complex enough to be the outcome of many successive improvements, the bow and arrow of a savage. I will not describe the bow, but the arrow is of wood or reed. It is pointed with metal, flint, or bone, and the point, which is barbed, is bound in place by strips of sinew. The butt is notched and feathered, sometimes with three feathers set on spirally. If we knew nothing of the history of this instrument, we could read in its structure that it was the result of growth, that human ingenuity never at once could have originated it as perfected, but that the details mentioned point to long ages of experience and successive improvements. We cannot tell, in all respects, in what order these improvements have been made; but we are safe in saying that the arrow, in the form of a dart or light lance, must have antedated the bow, while some of its peculiar features, such as the spiral feathering, most probably were added to it since the invention of the bow. The true order of elimination then appears to be to drop first the spiral feather, then perhaps all feathering, then the notched butt, along with the bow itself, leaving a light, pointed and barbed lance, of which the Zulu assegai or the Greek javelin may be taken as types. Both of these are familiar from drawings and otherwise, and need not be described in detail, the shaft and barbed metal point being their leading characteristics, and both being adapted for either thrusting or hurling. Assuming that the progenitor of the arrow was a weapon of this character, we proceed in our work of elimination by taking away the metal point and substituting a point of ruder material—stone or bone. A barbed point is evidently an improvement on a plain lance point, so we next eliminate the barb. But the shaft having an attached point of harder material must have been preceded by a shaft having its point integral with it, a mere pointed rod, the type of which is used by the aborigines of South America in both their arrows and lances. To what does the next step in elimination lead us? To an unpointed rod, a blunt stick adapted for striking as well as thrusting, the bough of a tree broken off by the wind, or a stalk of cane—any rude provision of accident unmodified by human effort. Such a stick, in the hands of a person who used it with a thrust, and adapted or selected for such use, is the rudimentary type from which have come the lance, the arrow, the bayonet, all thrusting tools and weapons, even the spade and plough. Used as a striking implement or weapon, and selected or adapted for such use, from the same rudimentary type were evolved the club, the hammer, the axe, the sword, and all tools and weapons whose effectiveness depends on a swinging blow. If we had been pursuing the history of the axe, or sword, or spade, we should have reached the same result.

So many elements enter into every mechanical structure of our day that in attempting to read back their history we are like one who explores a river upward from its mouth. He must pass by many a minor affluent, and pursue that which appears to be the main stream. He may even mistake a tributary for the main stream, and so reach an ultimate source widely different in locality from the actual one. No river, however, is fully explored till all its tributaries have been followed to their sources; and equally the history of no invention has been gathered until each of its components has been separately traced to its own near or remote origin. But as the little spring in western New York, which may give rise to the Alleghany, differs in no essential particular from the little spring thousands of miles away, from which the Missouri may take its ultimate rise, so with the two important elements, the shaft and attached point, which constitute the arrow. Some time in its history they have come together. I have chosen to eliminate the point as the subordinate and tributary element. If we prefer to eliminate the shaft and pursue the history of the point, we must take it as a type of cutting and piercing implements. We shall pass from knives of steel to knives of bronze, thence to knives of polished stone, thence to a ruder form of dressed flints, thence, perhaps, to such flakes of flint, or slate, or other material as presented themselves to man without preparation. Here, as in the case of the shaft, we find man in a state of nature using no art, but selection only. The shaft led us to a stick, the point, to a stone. The cutting edge which man found in a shell or splinter of cane might answer his purposes equally well, but whether shell or cane, or slate or flint, he used only what nature provided.

If, instead of following up the cylinder and piston of the steam engine, we had discarded these and pursued the history of the crank, so conspicuous in its structure, we could not trace it back of a recent historic period. Compared with the antiquity to which this study reaches, it is a modern invention, if not modern actually; but the wheel to which it is attached, if followed up, will lead us back through many intermediate steps to a savage rolling together logs and boulders for a shelter or defence. Here again, so far as able, he would use his selection out of what nature provided, but artificial preparation there was none.

From illustrations like these of the elaboration of inventions, (and they might be indefinitely multiplied,) it appears that the appliances, the arts, the tools and complex engines of modern industry and war may all be traced back to rude types in a few simple mechanical expedients which man possessed at his earliest origin, and employed, guided by his own selection, and which have been supplemented by other expedients from time to time discovered or invented.* In the whole circumference of the arts every radius leads to the one center, where we find man, with intelligence enough to choose from what nature has provided that best adapted for his use, but, as yet, without skill or knowledge to alter or modify the rude material she furnishes.

What were these expedients of primitive man?

Such slight consideration as I have been able to give them, together with a contemplation of correlative facts in natural history, leads me to this belief: that the mechanical expedients possessed by the earliest human beings were such, and such only, as they possessed in common with the brutes. This belief is not affected by the question whether man was himself the product of evolution or of a special creation. The only difference would be that what in one case he possessed by inheritance, he must have acquired in the other by imitation. The question to be answered is, therefore, what were the mechanical expedients possessed by the brutes, which primitive man with his structure and needs may have inherited or imitated?

Without considering the wonderful manifestations of instinct in the higher mammals, or the ingenious contrivances of birds and insects, I shall regard only what is displayed to us in the natural history of those animals which are nearest to man in their physical structure, and from whom, or from creatures like whom, he must have inherited his earliest habits and instincts, or from observation of whom, he may have derived his notions regarding food, shelter, and the maintenance of his existence.

Since all the Simiadae are arboreal in their habits, we find them largely marked by similar characteristics, while in the Anthropomorpha there are special habits particularly claiming our attention. It is not always easy in a study of these to distinguish between the habits of the animal in its wild state, and those it has acquired by training or association with man. Unfortunately, writers on the habits of the apes and monkeys have generally studied them in the wire cages of the Botanical Garden, or as domestic pets, or possibly as stuffed specimens, and reliable details of their habits and practices when unaffected by the interference or proximity of man, are quite limited. Out of voluminous narratives of their instinct and cunning while under habitual human observation, with which popular works on natural history abound, I have culled a few facts which appear to relate to these animals in their natural state. I have not attempted to group or classify them, but present them in the order in which I happened to meet with them.

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* Since this was written I have met with Mr. John Evans' address before the Department of Ethnology and Anthropology of the British Association for the Advancement of Science, at Liverpool, in 1870, in the course of which occurs the following language: "As the most eminent living naturalist conceives it not only possible, but probable, that all animals have descended from, at most, only four or five progenitors, and all plants from an equal or lesser number, so I think that an examination of the history of human arts and manufactures will reduce the material appliances possessed by our first progenitors to at least as small a tale." There are numerous hints in the same address that I would have found valuable in the preparation of the present paper, which may be regarded as a chapter in such an examination as Mr. Evans suggests. It is gratifying, however, to find some of the views I have enunciated confirmed in advance by the opinion of so eminent an authority.

Some monkeys, in order to extract the meat from oysters, have been observed to thrust stones between their open shells. This is stated as a general fact, not attributed to any particular tribe or species.

Natives of the Gaboon country say the Chimpanzees unite to attack the elephant, the lion, and other beasts of prey with clubs and stones.

The Entellus will catch a sleeping snake by the neck and grind off his head on the nearest stone.

Some species of Cercopithecus fill their paws with dust or sand, and fling it at their assailants.

The Diana monkey used a stone to crack nuts and almonds.

The Green monkeys break off branches of trees to throw down on their enemies.

Of the Magot or Barbary ape it is said that they frighten and in some degree command the huge animals of the forest by pursuing them with hideous cries, and throwing down branches of trees on them. This practice of throwing down branches of trees is also related of the Stentor, one of the American apes.

The Atiles or Spider monkey catches mussels and oysters and crushes their shells by pounding them with stones.

Possibly careful search would fully confirm these meager facts. It is not likely it would add to them materially. Such as they are, they admit of a rude classification into—

1st. The use of stones as implements, involving the notion of the hammer and the wedge.

2d. The use of stones as missiles; and under this head I use the word stone as generic, including anything within the animal's reach adapted to be thrown by the hand.

3d. The use of branches of trees or sticks as clubs.

4th. The use of the same as missiles.

Beyond these, and of the greatest moment to this inquiry, is the well-recorded habit of shelter building by the Anthropomorpha, at-attributed to every species. Many writers allude to this, but the only description I have been able to find is by Du Chaillu, who says of the Nshiego-Mbouve, a species of Chimpanzee: "They build a kind of leafy nest among the boughs of the loftiest trees. This nest is composed of small interlaced branches, well thatched with leaves, and impenetrable to water. Fixed by firmly tied bands, it is generally from six to eight feet in diameter, and presents the form of a dome, an arrangement which readily throws off the water."*

From this incomplete description we conceive of a structure like the following: after a place has been selected in which the boughs by their natural forms and relations are adapted to the purpose, they are brought together so as to form a skeleton, or frame work. The interstices are then partially filled by interlacing either the smaller branches and twigs of the same boughs, or broken branches from the same or neighboring trees. Over this is laid a thatch of leaves, and the whole is secured by bands passing over it, which may be strips of some tough bark, flexible vines, or withes. Possibly this conception is more perfect and elaborate than the actual structure; but whether this is so or not, the mechanical expedients employed by the builder are most important additions to the list already observed. These are (5th) interlacing, or plaiting, which consists in passing the boughs in and out transversely of other boughs, in the familiar form of a hurdle or wattled hedge; and (6th) tying, the well known and only original method of securing two parts of a structure together by a third piece, of some flexible material. The important expedients of the thatch and sloping roof are also worthy of notice.

With our limited knowledge of the habits of these brutes in their native state, it is quite possible that we have not enumerated all the mechanical expedients they possess. Such as we have found are enough for the present purpose. No one can imagine that man, in the lowest condition that may be attributed to him, can have possessed less. I shall therefore from this point regard them as his original endowment, in which can be recognized elements for the supply of all his prime necessities—food, shelter, and defence. As yet raiment was not a necessity.

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* I quote this from Figuier's Mammalia, page 603. The author attributes it to Du Chaillu without naming the work in which it is found.

The stone was an implement with which he procured food. Living on indigenous fruits and roots, and edible fungi perhaps, he seldom had use for implements; but the spectacle of a group of boys about an apple or chestnut tree reminds us how the stone might be used to bring down the fruit, and it obviously served a convenient use in cracking nuts, and as a wedge in circumventing the modest oyster. As a missile it was a means of attack and defence against savage beasts. The original uses of the stick were similar. It was both a striking and hurling implement, and was used both for procuring food and for attack and defence.

The expedients employed in the construction of his shelter were presumably not at first used by man for any other purpose; but they involved the two arts of tying and plaiting, and for the practice of the former the possession of the thong of bark or withe.

Man must have supplemented these expedients with the knowledge of some material facts. He observed, for instance, that bodies left to themselves fall to the ground, and he can hardly have failed to recognize this as a general truth from the moment he was capable of any sort of generalization. He could distinguish such properties in bodies as weight and lightness, that some float in water while others sink, and that some are easily wafted by the wind while others hold solidly against it. He had lacerated his hands and feet on the sharp edges of rocks and shells, and thorns and briars had pierced his flesh, so that he must have known the cutting edge and penetrating point long before he availed himself of them for any use. These did not require to be discovered or invented, but were a provision of nature, waiting, as doubtless many provisions of nature are waiting yet, for the sluggish human mind to find uses for them.

The conditions under which man employed these expedients differed widely from those under which they were used by the quadrumanous and arboreal creatures in whose possession we have found them. Erect, plantigrade, and terrestrial, striking and hurling implements have acquired in his hands a new importance. Their use, hitherto frantic and incidental, has become deliberate and habitual, and, through the higher structure and continued practice, skill, precision, and effectiveness have been developed. The shelter, built by the Chimpanzees in the tops of trees only, and framed from the growing boughs, man forms from contiguous saplings bound together at their tops, and supplemented by gathered poles or reeds.* New materials may have found their way into its structure, and it may have increased in dimensions and in its adaptedness for permanent use.

Whether reason be a growth or a new faculty bestowed complete upon man, its first practical employment must have been upon material things, such as he was most immediately concerned with. His daily pressing wants, the means of securing food and shelter and repelling attacks, these were the subjects of his contemplation. By such contemplation and his acquired dexterity, supplemented by the narrow range of facts within his knowledge, he is guided to new expedients. For instance, observing the solidity of rocks and bowlders, he might have secured his shelter by lashing it to them. He might have found in grass and rushes more suitable materials than the boughs and leaves for binding the poles and saplings of its frame, for weaving into its interstices, and for its thatched roof. He may have become dexterous in the arts of thatching and plaiting, and learned new and varied and secure forms of knots. Useing his judgment and selection, with experience he discerned what stones and pebbles were best adapted for his various uses, the round pebble of the brook for hurling, the sharp-edged flake for a wedge, and such stones as afforded a convenient hand-grasp for striking. In the same way he found that particular forms of sticks were better adapted for special uses; that to strike a powerful swinging blow, the greater weight should be remote from the hand; while for effective hurling, it might be more evenly distributed. And he found new uses for the stick. He may have acquired its use as a lever, and so possessed two of the mechanical powers. But we must ascribe to an early period among the distant ages under consideration the first employment of the stick as a thrusting weapon. Herein is a clear separation from all brute usages, which seem to be confined to aimless brandishing, striking, and throwing; and for its effective use in this way, man must have observed that instead of having the heavy end remote from him, as for a swinging blow, the smaller end must be advanced; and so with no notion yet of improving on nature or accident by artificially pointing his stick, he selects for use with a thrust such sticks as are slender and reduced at their extremities. In these improved methods of using the old expedients, in these rude steps in progress marked by departures from brute usages, we may discern the feeble exercise of reason. Man did not begin at once to reason profoundly. His first notions of cause and effect, and of adapting means to ends, were of the humblest character, restricted by the narrow range of facts in his possession. With so slender a store of facts the reason of Newton or Bacon could have had no wider scope.

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* Compare this with the description of the first human shelter given by Viollet le-Duc in his charming work, "Habitations of Men." "Epergos selects two young trees a few paces apart. Climbing one of these, he bends it down by his weight, pulls towards it the top of the other, and thus joining the branches of the two, ties them together with rushes. The creatures round him find other young trees in the neighborhood. With their hands and with the help of sticks they uproot them and drag them to Epergos, who shows them how they should be inclined in a circle by resting their tops against the first two trees. Then he shows them how to fill in the space with rushes, branches, and long grass interlaced, then, how the roots should be covered with clay, and the whole structure successively, leaving an opening on the side opposite the wind." The author appears to have reached the notion of this shelter by a process of elimination, but it is evident he could have gone a step further, and found its origin, without the need of calling in the aid of a superior being.

In the ground I have gone over, I have roughly traced the original stock of mechanical expedients through three stages: their use by brutes, which we may regard as at the most casual and fragmentary; then their habitual use by man; and then their use by man under conditions involving judgment, selection, and dexterity. The next stage is one in which improvements begin to be made on the old expedients in adapting them to new uses and to the supply of new wants. This is the first stage of invention.

It would be impossible to determine what was actually the first of human inventions. It is probable that instead of one there were several, called forth by diverse needs and conditions, and so nearly contemporaneous that neither can be regarded as antedating the other. I think it might be shown also that there exists a certain natural order in mechanical invention, under which the process and and product precede the tool or machine by which they are afterwards produced. We may be sure that the notion of striking is older than the rudest artificial striking implement; that of propelling the arrow, than the bow; that of navigating the water, than boats; those of pottery and a textile fabric, than the wheel and loom. The process is performed and the product realized by some already known and rude expedient before the demand is created for improved tools to perform the process. Hence, we ought to expect the first inventions to be arts or processes rather than products or implements. Necessity is, in a certain sense, the mother of invention, but this is by no means the whole genesis. The history of the subject will show that the necessities which give birth to inventions are generally the offspring of prior inventions or prior known expedients. Keeping these considerations in view, let us briefly consider the form which two or three primitive inventions may have taken:

1. The club did not need to be invented. It was a stick, in which roughness was no objection, and which, as experience had taught, operated most effectively with a heavier and lighter end. Since this is the natural form of growing wood, nothing but selection was required to provide man with this weapon from the boughs torn from the trees by wind or otherwise. So with the hurling stick. Improved forms and fashions may have developed at a later period with the introduction of the art of wood-working; but for the period in question these weapons were the gift of nature. As I have before said, however, man had found a new use for the stick—as a thrusting weapon; and I cannot but conceive that this use, once acquired, must have been a favorite one. By means of it a comparatively heavy blow is struck with a light shaft, and, at the same time, it was observed that the attitudes required in its use, in attack and defence, were securer than those necessitated in the use of the club. One is a cover as well as a weapon; the other leaves the whole body exposed. In contests of every kind this advantage was not to be overlooked. As compared with the club, the pike is the higher type of weapon, exactly as the rapier is in comparison with the broad sword, or the bayonet with the battle axe, and in its use, even in the primitive form of a blunt stick, man must have been conscious of new power. He was not long (as we must reckon time at that period) in finding the adaptation to this use of splintered fragments of timber, which accident had pointed, and in the

exercise of his selection such splinters were eagerly sought for and may have been carefully treasured.

There came a time when, pointed sticks being in demand, some genius conceived the idea of artificially pointing a common stick. In dragging over the rocks the poles for his shelter he had observed the abrading effect on their ends, and putting his knowledge to practical use he pointed a shaft by rubbing it on the rough surface of a rock. Here was an actual invention of the first magnitude—not of the pike be it observed, nor of the rough rock, these existed already; but of the art or process of working wood by abrasion.

This art, once introduced, must have become a prolific parent. When man found it in his power to modify or improve the form of timber, he may have begun to apply the art to the perfection of his club—as in giving it a more convenient hand-grasp. The time was to come when he would find that the same result could be accomplished by applying a scraping or cutting implement to the wood, rather than the wood to the rock, and then he would begin to devise implements for convenient use. He was also to find that he had the power to change the form of other materials, such as shell or bone, and would devise appropriate processes and tools for the purpose. But these are more advanced steps in invention, with which we are not now dealing.

2. Another of man's original endowments was the use of the stone for throwing. By his power of selection he had determined what stones and pebbles were best adapted to his purpose, and by virtue partly of his higher structure, partly of his practice, had acquired expertness and precision. Important as this expedient was to him, the throwing stone once used was no longer of value and was left where it fell.

I can conceive that in his wanderings man may have come upon vast alluvial regions, where for long distances not a pebble was to be found. Here fruits and nuts adapted for food were growing, but practically out of his reach for want of his accustomed means of procuring them. Here also were savage beasts, but his accustomed means of defence against them were wanting. It might then have occurred to him to transport thither pebbles from some other point. In attempting to carry out this project he was met, as men have ever since been met in handling artillery, by the problem of transportation. Nature, which had blessed the Cercopithecus with cheek-pouches and the marsupials with capacious pockets, had not been so beneficent to the *genus homo*. His carrying capacity was limited to what his two hands would hold. Vessels and receptacles of every kind were for the future to devise. How was the inventor of the day to solve the problem? It has been remarked that man had probably lashed his shelter to the rocks and bowlders, and in doing this had learned to secure a thong to loose and rounded stones about which it could be passed. These were larger and smaller, sometimes with his untrained judgment too small for much service, and in such instances they might often have been moved about by the thongs attached to them. It could not have been an extraordinary suggestion to put this expedient in practice to supply the new want. While, without some such expedient, man was limited in his carrying capacity to a pebble in each hand, he found that, by securing a slender thong to each, he could carry (or drag) quite a number in each hand. Here was a combination* of the thong with the pebble; two old elements uniting to form a new structure with special functions, and in it were all the elements of invention. But, like Humphrey Potter's *scoggan,* there was more in it than the inventor thought of. It solved the question of transportation, as his invention did that of playing marbles; but when the weary man, after a toilsome day's travel with his unaccustomed burden, was about to seek repose and carelessly tossed it from him, he could have observed that he had done much more than to make a conveniently portable missile, and had added new effectiveness to the missile itself. By means of the thong he had given the stone greater velocity and longer range, and practically added to the power of his own arm. In short, he had invented the precursor of the *bolas,* the effective weapon of the Patagonians. We can see the type of it in the slung-shot, the convenient and deadly contrivance favored by the savages of New York and London.

Out of this invention afterwards grew another. Some pebble, insecurely fastened, flew from its lashing and went whirling far, leaving its thong in the thrower's hand. A number of experiences like this might have suggested such a contrivance of the lashing that the stone could be discharged at will; and the sling was invented, of the type of that made by the ancient inhabitants of Sweden out of the bark of the linden. While these do not appear to have been the parents of numerous inventions, having at a remote period been generally supplanted by other forms of arms, they may be regarded as containing the first suggestions of long-range missiles, and we may trace to them such engines as the ballista and catapult, and, by a very slender connection, the cannon and other fire-arms.

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* I use the word "combination" in the strictly technical sense of patent law.

3. Among the rude expedients employed by primitive man in the construction of his shelter was that of interlacing smaller lateral boughs with the upright poles or saplings. It is not unlikely, as I have before remarked, that at a very early period he so far modified this expedient as, when the conditions favored, to interlace grass or rushes with the boughs, and by this better material to increase the tightness of the structure. From plaiting or interweaving rushes with boughs it was but a short step to plait rushes with rushes, to make movable parts to cover needful openings; and so was formed the rush mat—the parent and prototype of all textile fabrics. Here was an invention involving both the process and product, long before flax was spun or flocks kept.

4. In the construction of his shelter with light and insecure materials, stability had been attained by lashing it to such objects as had great weight or were firmly fixed in the ground. Roots and fallen trunks, rocks and bowlders had answered to these conditions; but their use left the builder without the free exercise of his selection as to the place his shelter should occupy. In using these means quite frequently the spot would be one exposed, in case of storms, to overflow or to be swept by torrents; and it was a suggestion of no small moment to roll the loose bowlders from their native beds to higher ground, and secure the frail fabric to a number of them arranged in a circle about it. Here was the first step in the use of more lasting materials in architecture, and an invention which was to transform the temporary shelter into the permanent house. From a mere ring of anchoring bowlders came in time the foundation, raising the superstructure from the ground, and by additional courses reaching some rude form of Pelasgic wall.

If any of these inventions seem to be puerile, it is to be remembered that we are dealing with the remotest infancy of the human race. In the condition in which man must be presumed to have been at this period, they are inventions of a high order. I have selected them because they grow naturally out of the expedients with which man was primitively endowed, and because they may have been, and some of them must have been, made long before any dressing of flints or bone or the artificial preparation of any material that can long survive the action of natural decay. Indeed, unless all reasoning from analogy is at fault, the working of the softer material must have preceded the working of the harder. Man must have constructed pointed instruments of an inferior character and learned their value, before he conceived the idea of improving them by attached points of better material, or of constructing tools to make them better and more expeditiously. The remains of these early arts will never disclose themselves to archæologic research. The wood and bark and rushes have passed away, and the pebbles that may have been so effective in peace and war are indistinguishable from any pebbles of the brook. But we do not need this material evidence. No art is known to us that has not grown up from simpler and ruder arts. This is a truth which does not belong to our time, but to the arts themselves. What is true of the inventions of Watt and Edison is true of those of Osiris and Tubal-Cain, and equally true of those of the unknown and naked savage, whose arts form the subject of our inquiry; and we need no further assurance that back beyond the remotest period to which the rudest wrought stone implements can be ascribed, a thinking, reasoning, inventive man must have developed arts and progress capable of leading up to the construction of such implements.

I hope it will not be forgotten that the title of this paper restricts it to an inquiry. I have attempted to demonstrate nothing, since I had no preconceptions to maintain, or at least none which the first steps in the inquiry did not remove. The convictions I have stated are those which have formed in my own mind during the preparation of the paper, and since they point to conclusions quite at variance with those of prominent European anthropologists, I beg leave to dwell on them a moment, and to state the nature of these conclusions.

In Prof. Boyd Dawkins' recent valuable work on "Early Man in Britain,"* he discusses at some length the probabilities of man's existence in the different successive stages of the Tertiary period, finding no proof of his appearance till the Pleistocene. It having been maintained by very high authority on the other side of the

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* London, 1880.

British channel that man inhabited France as early as the middle of the Miocene, he alludes briefly to the evidence on which that opinion is partly founded, to wit: the flint splinters found in the Mid-Miocene strata of Thenay. He expresses doubt* as to whether these splinters are actually artificial, and suggests that, if they are so, they may have been the work of one of the higher apes rather than of man. This view, he adds, agrees with that of Prof. Gaudry, who had suggested as their author the Dryopithecus, the great anthropoid ape then living in France. This view is quite earnestly combatted by Mr. Grant Allen, in a paper entitled "Who was Primitive Man?" in the *Fortnightly Review* for September, 1882, in which the writer declares his belief in the artificial origin of these rude splinters, and the evidence that they are of the Mid-Miocene period, but ascribes them to what he calls "a man-like animal," "acquainted with the uses of fire, and sufficiently intelligent to split rude flakes of flint," such a creature being in his view one of the links in the evolution of man, and his existence at that period being in harmony with that doctrine. These flints have occasioned much discussion in Europe, and the opinions quoted are fairly representative of those expressed by many authors.

It is clear that neither to Prof. Dawkins and Prof. Gaudry, nor to their critic, is it hard to imagine that a creature, inferior to man both in physical and mental structure, may have made such progress in art as to be able to work so difficult a material as flint, and have developed such wants as to call for the practice of that art. If they do not mean this, their language is meaningless.† There is no practical difference between their notions. Both lose sight of the nature of art and the laws of human progress, and both indicate a conception of art prior to man, but an inability to conceive of man as existing without a certain degree of progress in art.

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* A very reasonable doubt in view of the result of the careful examination made by a jury of fifteen experts at the Prehistoric Congress at Brussels, in 1872. Five members of the jury declared that they could not discover any evidence of human workmanship in the thirty-two specimens exhibited.

† In a foot-note (p. 69) Prof. Dawkins says: "Even if the existing apes do not now make stone implements or cut bones, it does not follow that the extinct apes were equally ignorant, because some extinct animals are known to have been more highly organized than any of the living members of their class." When the question is regarded from its mechanical side, the pertinency of this suggestion is not obvious. It does not turn on actual knowledge how to shape flints, but on the process by which that knowledge was gained, and on the development of wants which made the exercise of the knowledge necessary. It is safe to presume, on the basis of evolution by natural selection, that, if at any geological period prior to the advent of man, apes had made the progress in art claimed for them, there would have been no room for man on earth: his place would have been taken.

In fact the conception of man as existing prior to the fabrication of stone implements seems to be foreign to the ideas of those who have discussed his origin and antiquity. In the minds of anthropological writers it would seem that the first human creature, whatever his origin, must have signalized his advent and perpetuated his memory literally in a

"*Monumentum aere perennius*," *

by instantly, without preparation or conscious need, chipping out tools of flint. Only in the fancy of a Roman poet, who had never heard of neolithic or palæolithic ages, do we find a conception of the rudeness and absolute dependence on the gifts of nature of the primitive man, whose earliest arms were his fists, nails and teeth, and stones and broken limbs of trees.†

Coming to this subject, not as a student of the antiquity of man, but only as one whose daily business is the study of inventions, I find it presents to my mind an aspect more like the poetic fancy of

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* Horace, Lib. III, Ode 30.—The poet, in the following lines, well describes the enduring character of these memorials:

"*Quod non imber edax, non Aquilo impotens*
Possit diruere, aut innumerabiles
Annorum series, et fuga temporum."

† Lucretius' *De Rerum Natura*, Lib. V:
Arma antiqua manus, ungues, dentes fuere,
Et lapides, et item sylvarum fragmina rami.

The quotation is familiar, having been cited in connection with the four succeeding lines, to show that the conception of three stages of civilization known as the ages of Stone, Bronze, and Iron were recognized by the ancients. I hazard the criticism that, while it clearly indicates a bronze period earlier than that of iron, it contains nothing that was meant to suggest what is now understood by the stone age. There is nothing in *lapides* that implies that the stones are wrought in any way, or are anything but such provision as nature furnishes in loose fragments and pebbles. The poet puts them in the same category and in the same stage with *fragmina rami*, which certainly does not mean dressed timber. I doubt if *lapis* is ever used for a flint stone. Some authors (see Vitr. 8, 1) use *saxum silex*, and Plautus (Capt. 3, 4, 84) uses *saxum* alone for a flint implement with which victims were slain.

Lucretius painted it than like that of the authors I have quoted. The maxim "Art is long," is true, not only of its duration, but of its growth; and in this sense not more true of the finished work of the Greek sculptor, than of the jagged flints, our only memorials of man in the earliest of the uncounted centuries of the palæolithic age.

The dressing of flint in any rude form by any creature must have begun long subsequently to the dressing of less difficult materials, since some such antecedents were necessary to develop the need of flint implements and the art of producing them. Hence I cannot conceive that the flints of Thenay, if artificial, can be the production of any creature less than a fully developed man. The human attributes of thought, reason, and invention were necessary for their fabrication, because all these were required in the antecedent steps which led up thereto. To me it is as easy and reasonable to attribute to an ape or a man-like animal the first wrought bronze or iron as the first wrought flint. Not less true, if applied to the mechanic arts, is William Humboldt's pregnant paradox: "Man is man only by means of speech, but in order to invent speech he must be already man." Indeed this thought applies with greater emphasis to mechanical invention than to vocal speech. We can easily suppose that man may have made as great advance in arts as I have described in this paper before his unformed speech had become distinguishable from the chatter of the beasts around him. It must have been one of the immediate results of his early mechanical progress to give large increments to language by the new ideas and wants which the arts engendered. It is not impossible that spoken language may have originated at this era, and so the man who invented speech must prior thereto have been a man by means of his mechanical inventions—to make which he must have been already man.

We should probably search in vain among the lowest savage people known to us for a living type of our most ancient human progenitor; low as his type may have been, he was neither anthropoid nor pithecoid, but completely human, whether he made his appearance in the Post-Pliocene or in the Mid-Miocene, or whether he was the product of a special creation a few thousand years ago.

Obviously archæology can find no trace of a remoter age than that of stone, but I mistrust that the thoughtful anthropologist will accept the evidence of earlier ages, one of which, taking one of its perishable materials as the type of all, we may call the age of wood. Still further back must lie an age, as indefinite in duration as any, when man existed in his rudest condition, without arts of any kind, except such as he employed in common with lower animals, and this is the true primitive period. In such ages as these, just on the hither side of the indeterminate border which divides man from the brute creation, we must look for the beginnings of his mechanic arts, and with them of human history.

The discussion was participated in by Messrs. Rock, Mason, Fay, and others.

Mr. IVAN PETROFF then read part of his paper on "ALEUTIAN SONGS AND TRADITIONS," the hour of adjournment having arrived before he concluded.

SIXTY-SIXTH REGULAR MEETING, March 6th, 1883.

Colonel GARRICK MALLERY, President, in the chair.

The Secretary, in the absence of the Curator, reported the following gift:

From the ACADEMY.—Antiquarian proceedings from the Kongl. Vitterhets Historie och Antiquitats Akademiens of Stockholm, for the years 1872–'81, inclusive.

Mr. PETROFF then read the concluding portion of his paper on "ALEUTIAN SONGS AND MYTHS," of which an abstract has been been submitted.

ABSTRACT.

After referring briefly to the origin of the term *Aleut*, which he traced to the Kamchatkan river Olutora, and a group of islands named after the same on the earliest Russian maps, the speaker expressed the opinion that the tribal name of the people should be pronounced Unangan instead of Unŭngŭn adopted by Mr. Dall, the former reading being also supported by the authority of Veniaminof. Mr. Petroff then recited some traditions of the origin of man, the earliest having been collected in 1815 by Louis Choris. Nearly all these myths represent at least one of the first couple as a dog, the children gradually assuming human shape. The myths also